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APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
10/734,086	12/11/2003	Charles M. Lieber	H0498.70203US01	7978

7590 04/07/2006  
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EXAMINER

MENEFEE, JAMES A

ART UNIT	PAPER NUMBER
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2828

DATE MAILED: 04/07/2006

Please find below and/or attached an Office communication concerning this application or proceeding.

11A

<b>Office Action Summary</b>	Application No. 10/734,086	Applicant(s) LIEBER ET AL	
	Examiner James A. Menefee	Art Unit 2828	

-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --

**Period for Reply**

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE 3 MONTH(S) OR THIRTY (30) DAYS, WHICHEVER IS LONGER, FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133). Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

**Status**

- 1) ☒ Responsive to communication(s) filed on 11 January 2006.
- 2a) ☐ This action is **FINAL**.                      2b) ☒ This action is non-final.
- 3) ☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

**Disposition of Claims**

- 4) ☒ Claim(s) 1-129 is/are pending in the application.
- 4a) Of the above claim(s) 1-37, 90-107, 124 and 125 is/are withdrawn from consideration.
- 5) ☐ Claim(s) \_\_\_\_\_ is/are allowed.
- 6) ☒ Claim(s) 38-89, 108-123 and 126-129 is/are rejected.
- 7) ☐ Claim(s) \_\_\_\_\_ is/are objected to.
- 8) ☐ Claim(s) \_\_\_\_\_ are subject to restriction and/or election requirement.

**Application Papers**

- 9) ☐ The specification is objected to by the Examiner.
- 10) ☐ The drawing(s) filed on \_\_\_\_\_ is/are: a) ☐ accepted or b) ☐ objected to by the Examiner.  
Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).  
Replacement drawing sheet(s) including the correction is required if the drawing(s) is objected to. See 37 CFR 1.121(d).
- 11) ☐ The oath or declaration is objected to by the Examiner. Note the attached Office Action or form PTO-152.

**Priority under 35 U.S.C. § 119**

- 12) ☐ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).
- a) ☐ All    b) ☐ Some \* c) ☐ None of:
1. ☐ Certified copies of the priority documents have been received.
2. ☐ Certified copies of the priority documents have been received in Application No. \_\_\_\_\_.
3. ☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).

\* See the attached detailed Office action for a list of the certified copies not received.

**Attachment(s)**

- |  |   |
|--|---|
| 1) <input checked="" type="checkbox"/> Notice of References Cited (PTO-892)  | 4) <input type="checkbox"/> Interview Summary (PTO-413)<br>Paper No(s)/Mail Date. _____ |
| 2) <input type="checkbox"/> Notice of Draftsperson's Patent Drawing Review (PTO-948)                                   | 5) <input type="checkbox"/> Notice of Informal Patent Application (PTO-152)             |
| 3) <input type="checkbox"/> Information Disclosure Statement(s) (PTO-1449 or PTO/SB/08)<br>Paper No(s)/Mail Date _____ | 6) <input type="checkbox"/> Other: _____  |

### **DETAILED ACTION**

Note there is a new examiner of record in this application. See communication information below.

#### ***Election/Restrictions***

Applicant's election with traverse of group II in the reply filed on 1/11/2006 is acknowledged. The traversal is on the ground(s) that examination of all claims would not be a burden. This is not found persuasive because a search of group II does not entail a search of the subject matter of group I; that is, in searching for a nanoscale wire that generates stimulated emission of radiation, there is no need to search for a device having a second nanoscale wire as required in group I. Such an additional search is deemed a burden sufficient to uphold the restriction requirement. The requirement is still deemed proper and is therefore made FINAL.

Note that the examiner believes that certain claims were erroneously assigned to the two groups in the prior restriction requirement. It is believed that claims 90-91 belong to group I as these claims require two nanoscale wires, while 126-128 belong to group II. Therefore, the examiner modifies the requirement to that extent, and will examine claims 126-128 with elected group II but will withdraw 90-91 from further consideration.

Thus, claims 1-37, 90-107, and 124-125 are withdrawn from further consideration pursuant to 37 CFR 1.142(b), as being drawn to a nonelected invention, there being no allowable generic or linking claim. Claims 38-89, 108-123, and 126-129 are examined herein.

***Claim Rejections - 35 USC § 112***

The following is a quotation of the second paragraph of 35 U.S.C. 112:

The specification shall conclude with one or more claims particularly pointing out and distinctly claiming the subject matter which the applicant regards as his invention.

Claims 66 is rejected under 35 U.S.C. 112, second paragraph, as being indefinite for failing to particularly point out and distinctly claim the subject matter which applicant regards as the invention. The claim depends on 69, therefore it ultimately depends on itself. It is believed the claim should depend on claim 65.

***Claim Rejections - 35 USC § 102***

The following is a quotation of the appropriate paragraphs of 35 U.S.C. 102 that form the basis for the rejections under this section made in this Office action:

A person shall be entitled to a patent unless –

(e) the invention was described in (1) an application for patent, published under section 122(b), by another filed in the United States before the invention by the applicant for patent or (2) a patent granted on an application for patent by another filed in the United States before the invention by the applicant for patent, except that an international application filed under the treaty defined in section 351(a) shall have the effects for purposes of this subsection of an application filed in the United States only if the international application designated the United States and was published under Article 21(2) of such treaty in the English language.

Claims 38-49, 51, 54-65, 70-85, 108-114, 117-118, 121, 123, and 126-129 are rejected under 35 U.S.C. 102(e) as being anticipated by Majumdar et al. (US 6,996,147).

Independent claims (see next page for explanation of where Majumdar discloses the limitations):

Regarding claim 38, Majumdar discloses an apparatus comprising at least one nanoscale wire constructed and arranged to generate amplified stimulated emission of radiation, the wire including a first type semiconductor, and a substrate, wherein the apparatus is constructed and

Art Unit: 2828

arranged such that at least first carrier types are injected along at least a portion of a length of the nanowire in response to an electric signal from the substrate, to facilitate generation of the amplified stimulated emission of the radiation.

Regarding claim 108, Majumdar discloses a method of fabricating a nanoscale wire comprising forming at least one nanowire from a first type semiconductor material, forming the nanowire into an optical cavity, and coupling the nanowire to an electrode formed from a second type of semiconductor.

Regarding claim 117, Majumdar discloses a method of fabricating a nanoscale wire optical cavity comprising formed at least one Bragg grating on the nanowire. Note Majumdar discloses the device may be a distributed feedback laser, and such lasers necessarily include such gratings. See col. 26 lines 55-56.

Regarding claim 126, Majumdar discloses a method of generating amplified spontaneous emission of radiation comprising applying an electric signal along at least a portion of a length of nanoscale wire formed as an optical resonator.

Regarding claim 127, Majumdar discloses an apparatus comprising an electrical injection laser including a nanoscale wire constructed and arranged to receive carriers along at least a portion of a length of the wire.

Regarding claim 129, Majumdar discloses a device comprising a substrate and a nanoscale wire electrical injection laser integrated with the substrate.

For all of these claims, see col. 25 line 58 – col. 26 line 22; see also claim 1. Such a laser will necessarily generate amplified stimulated emission of radiation (for that is the “aser” in laser), and carrier types will be injected along a path of the nanowire. See col. 25 lines 60-65

Art Unit: 2828

discussing pn junction and electron hole recombination. The laser may be formed on a substrate, see example 7 cols. 28-32.

For the remaining claims, the rest of Majumdar is used as noted below. Note that Majumdar discloses that the nanowires of Majumdar's remaining disclosure may be used to make devices such as the electrically injected laser. See col. 32 lines 35-39.

Dependent claims:

Regarding claims 39-42, the nanowire may be made such that it has both n and p type materials, see Fig. 32, and both electrons and holes will be injected along at least a portion of the device, since the holes and electrons will be recombining at the junction. See also col. 9 lines 25-36, suggesting that various types of junctions may be included.

Regarding claim 43, see Fig. 32 and discussion on cols. 25-26. One could broadly construe the nanowire to be 268 and the electrode to be 266 and made of a second type of semiconductor material to form a p-n junction 264 such that in response to an electrical signal I carriers are injected into the nanowire via the electrode.

Regarding claims 44-48, 51, 109-113, Majumdar contemplates the various configurations due to the disclosure that various types of junctions can be used. See rejection of claims 39-42.

Regarding claim 49, 54-58, 73-78, 128, Majumdar discloses specifically several of the claimed materials, and additionally discloses the virtually any semiconductor may be used. Col. 13 lines 13-25. The various portions may also be doped.

Regarding claims 59-61, 79-81, the emission wavelength is dependent upon the active materials used. Use of the various semiconductors as disclosed will yield an output at the wavelengths as claimed.

Art Unit: 2828

Regarding claims 62-63, 82-83, the wire may have a diameter as claimed. See claim 1, col. 12 lines 18-21.

Regarding claims 64-65, 84-85, 118, 123, the wire may be arranged as an optical cavity. Col. 30 lines 61-63. The laser is formed between the two surfaces 336,338 (Fig. 43) and is by definition a Fabry-Perot cavity. The wire is also the gain medium.

Regarding claim 70, the nanowire may be formed as a core of semiconductor material and a shell of another semiconductor material to form a p-n junction. Col. 8 lines 31-66.

Regarding claims 71-72, the semiconductor junctions can be the various types as disclosed in col. 8 lines 61-66, and thus may be p or n type with electron or hole injection.

Regarding claim 114, metal 270 or 272 may be coupled to the nanowire. See Fig. 32.

Regarding claim 121, as the nanowire laser may be a DFB laser, see rejection of claim 117 above, it will necessarily have a Bragg grating as an end reflector.

### ***Claim Rejections - 35 USC § 103***

The following is a quotation of 35 U.S.C. 103(a) which forms the basis for all obviousness rejections set forth in this Office action:

(a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negated by the manner in which the invention was made.

Claims 50, 52-53, 66, 68-69, 86, 88-89, 115-116, 119, 122 are rejected under 35 U.S.C. 103(a) as being unpatentable over Majumdar.

Regarding claims 50, 52-53, and 115-116, the level of doping is not disclosed, nor the inclusion of an insulating layer such as aluminum oxide. It is known in lasers to provide a heavy

Art Unit: 2828

doping such as that claimed at the contact region where the current is injected, and it would have been obvious to one skilled in the art to do so in order to lower the electrical impedance at the place of current injection, as is known. It is also known to include an insulating layer such as aluminum oxide in this region, and it would have been obvious to one skilled in the art to do so in order to precisely control where the current is injected (since the insulating layer will prevent injection wherever it is located).

Regarding claims 66, 86, 119, it is not explicitly disclosed that the nanowire is cleaved to provide the end reflectors. Majumdar discloses in Example 7 that typically end facets of lasers are formed by cleaving, but in this particular instance using ZnO cleaving is unnecessary since the particular materials form well faceted ends through natural growth. Col. 31 lines 1-12. However, this suggests that Majumdar would use cleaving if the material were such that well faceted ends were not formed by natural growth. Majumdar discloses that virtually any semiconductor may be used to form the nanowires, thus it would have been obvious to one skilled in the art, based on Majumdar's suggestion that cleavage is typically used, to use cleavage when the material is another type of semiconductor that does not form well faceted ends through growth.

Regarding claims 68 and 88, Majumdar discloses there may be a Bragg grating, see rejection of claim 117 above.

Regarding claims 69, 89, 122, as noted above the nanowire laser may be a DFB laser, therefore there is necessarily a grating in the axial direction. The grating is formed by rulings where different materials/refractive indices meet, therefore it can be said that it is necessarily



Art Unit: 2828

produced by axial composition modulation, interpreted broadly as varying the composition along the axis.

Claims 67, 87, and 120 are rejected under 35 U.S.C. 103(a) as being unpatentable over Majumdar in view of Yang et al. (Adv. Functional Materials, May 2002). Majumdar discloses the limitations of the claims as above, but does not disclose the reflectors formed by solution phase sonication. Yang teaches that the nanowire lasers may be removed from the growth substrate by sonication and then placed on another substrate. See p. 329, 2nd col., last par. Such removal will yield an end facet of the laser by sonication as claimed. It would have been obvious to one skilled in the art to perform such sonication so that microscopy experiments may be performed, as taught by Yang.

### ***Conclusion***

The prior art made of record and not relied upon is considered pertinent to applicant's disclosure. The references disclose nanowire lasers.

Any inquiry concerning this communication or earlier communications from the examiner should be directed to James A. Menefee whose telephone number is (571) 272-1944. The examiner can normally be reached on M-F 8:30-5.

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, MinSun Harvey can be reached on (571) 272-1835. The fax phone number for the organization where this application or proceeding is assigned is 571-273-8300.

Art Unit: 2828

Information regarding the status of an application may be obtained from the Patent Application Information Retrieval (PAIR) system. Status information for published applications may be obtained from either Private PAIR or Public PAIR. Status information for unpublished applications is available through Private PAIR only. For more information about the PAIR system, see <http://pair-direct.uspto.gov>. Should you have questions on access to the Private PAIR system, contact the Electronic Business Center (EBC) at 866-217-9197 (toll-free).

A handwritten signature in black ink, appearing to read 'Jmf', is positioned above the printed name and date.

James Menefee  
March 31, 2006